

Art Unit 2652
Serial No. 09/943,859

Reply to Office Action of: July 19, 2005
Attorney Docket No.: 1012-003/K35R1694

Listing of Claims:

1. (Previously presented) A method for manufacturing a hard bias spin-dependent tunneling sensor comprising:
 - forming a first lead;
 - forming a first gap spacer adjacent the first lead
 - forming a hard magnet over the first lead, and around and in contact with the first gap spacer;
 - forming a free layer over the hard magnet;
 - forming a tunneling barrier layer over the free layer;
 - forming a first pinned layer over the tunneling barrier layer and overhanging the hard magnet;
 - forming a nonmagnetic coupling layer over the first pinned layer;
 - forming a second pinned layer over the nonmagnetic coupling layer;
 - forming a pinning layer over the second pinned layer; and
 - forming a second lead over the pinning layer.
2. (Previously presented) The method as claimed in claim 1 including:
 - forming the first gap spacer over the first lead; and
 - forming a second gap spacer over the pinning layer whereby the free layer is equidistant from the first and second leads.
3. (Previously presented) The method as claimed in claim 1 including:
 - forming the first gap spacer uses a bilayer process.
4. (original) The method as claimed in claim 1 wherein:
 - forming the first lead includes using a bilayer process in forming a recess therein;
 - forming the hard magnet includes forming a seed layer in the recess of the first lead; and
 - forming the hard magnet includes forming a hard biasing material over the seed layer.

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5. (original) The method as claimed in claim 1 wherein:
forming the free layer, the tunneling barrier layer, the first pinned layer, the nonmagnetic coupling layer, and the pinning layer includes using a bilayer process;
and including:
forming an insulator over the hard magnet and around the free layer, the tunneling barrier layer, the first pinned layer, the nonmagnetic coupling layer, the second pinned layer and the pinning layer.
6. (Currently amended) A method for manufacturing a hard bias spin-dependent tunneling sensor comprising:
providing a substrate;
forming over the substrate, a shield/first lead of a conductive material;
forming a first gap spacer adjacent the shield/first lead;
forming over the shield/first lead, a hard magnet containing a material selected from a group consisting of cobalt, chrome, platinum, tantalum, and a combination thereof, the first hard magnet being is formed around and in contact with the a first gap spacer;
forming over the hard magnet, a free layer containing a material selected from a group consisting of cobalt, iron, nickel, and a combination thereof;
forming over the free layer, a tunneling barrier layer containing a material selected from a group consisting of aluminum, chromium, an oxide, a nitride, and a combination thereof;
forming over the tunneling barrier layer and overhanging the hard magnet, a first pinned layer containing a material selected from a group consisting of cobalt, iron, nickel, and a combination thereof;
forming over the first pinned layer, a nonmagnetic coupling layer containing ruthenium;
forming over the nonmagnetic coupling layer, a second pinned layer containing a material selected from a group consisting of cobalt, iron, nickel, and a combination thereof;

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forming over the second pinned layer, a pinning layer containing a material selected from a group consisting of platinum, palladium, manganese, iron, nickel, iridium, an oxide, and a combination thereof; and
forming over the pinning layer, a shield/second lead of a conductive material.

7. (Previously presented) The method as claimed in claim 6 including:
forming over the shield/first lead, the first gap spacer from a nonmagnetic and conductive material; and
forming over the pinning layer, a second gap spacer from a nonmagnetic and conductive material whereby the free layer is equally spaced from the shield/first lead and the shield/second lead.

8. (Previously presented) The method as claimed in claim 6 wherein:
forming the first gap spacer uses a bilayer process.

9. (original) The method as claimed in claim 6 wherein:
forming the shield/first lead includes using a bilayer process in forming a recess therein;
forming the hard magnet includes forming a seed layer in the recess of the shield/first lead;
forming the hard magnet includes forming a hard biasing material over the seed layer; and
forming the free layer forms the free layer in contact with the hard magnet.

10. (original) The method as claimed in claim 6 wherein:
forming the free layer, the tunneling barrier layer, the first pinned layer, the nonmagnetic coupling layer, and the pinning layer includes using a bilayer process;
and including:
forming an insulator over the hard magnet and around the free layer, the tunneling barrier layer, the first pinned layer, the nonmagnetic coupling layer, the second pinned layer and the pinning layer.

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11. (Currently amended) A hard bias spin-dependent tunneling sensor comprising:

- a first lead;
- a first gap spacer adjacent the first lead;
- a hard magnet over the first lead, the hard magnet formed around and in contact with the a first gap spacer;
- a free layer over the hard magnet;
- a tunneling barrier layer over the free layer;
- a first pinned layer over the tunneling barrier layer and overhanging the hard magnet;
- a nonmagnetic coupling layer over the first pinned layer;
- a second pinned layer over the nonmagnetic coupling layer;
- a pinning layer over the second pinned layer; and
- a second lead over the pinning layer.

12. (Previously presented) The sensor as claimed in claim 11 including:
the first gap spacer over the first lead; and
a second gap spacer over the pinning layer whereby the free layer is equally spaced from the first and second leads.

13. (Canceled).

14. (original) The sensor as claimed in claim 11 wherein:
the first lead has a recess provided therein;
a seed layer in the recess of the first lead; and
the hard magnet is formed over the seed layer.

15. (original) The sensor as claimed in claim 11 including:
an insulator over the hard magnet and around the free layer, the tunneling barrier layer, the first pinned layer, the nonmagnetic coupling layer, the second pinned layer, and the pinning layer.

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16. (Previously presented) A hard bias spin-dependent tunneling sensor comprising:

- a substrate;
- a shield/first lead of a conductive material over the substrate;
- a first gap spacer adjacent the shield/first lead
- a hard magnet containing a material selected from a group consisting of cobalt, chrome, platinum, tantalum, and a combination thereof over the shield/first lead, the hard magnet formed around and in contact with the first gap spacer;
- a free layer containing a material selected from a group consisting of cobalt, iron, nickel, and a combination thereof over the hard magnet;
- a tunneling barrier layer containing a material selected from a group consisting of aluminum, chromium, an oxide, a nitride, and a combination thereof over the free layer;
- a first pinned layer containing a material selected from a group consisting of cobalt, iron, nickel, and a combination thereof over the tunneling barrier layer and overhanging the hard magnet;
- a nonmagnetic coupling layer containing ruthenium over the first pinned layer;
- a second pinned layer containing a material selected from a group consisting of cobalt, iron, nickel, and a combination thereof over the nonmagnetic coupling layer;
- a pinning layer containing a material selected from a group consisting of platinum, palladium, manganese, iron, nickel, iridium, an oxide, and a combination thereof over the second pinned layer; and
- a shield/second lead of a conductive material over the pinning layer.

17. (Previously presented) The sensor as claimed in claim 16 including:
the first gap spacer of a nonmagnetic, hard, conductive material over the shield/first lead; and

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a second gap spacer of a nonmagnetic, hard, and conductive material whereby the free layer is equidistant from the shield/first lead and the shield/second lead.

18. (Canceled).

19. (original) The sensor as claimed in claim 16 wherein:
the shield/first lead has a recess provided therein;
and including:

a seed layer in the recess;

and wherein:

the hard magnet is formed over the seed layer; and

the free layer is formed in contact with the hard magnet.

20. (original) The sensor as claimed in claim 16 including:

an insulator over the hard magnet and around the free layer, the tunneling barrier layer, the first pinned layer, the nonmagnetic coupling layer, the second pinned layer and the pinning layer.